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Design and implementation of a Wireless Voice Recognition System

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Abstract-Home automation is gaining popularity day by day in today's world, we require a system which is affordable and simple to implement. Both these qualities are present in this project, the main attraction of any automated system is reducing human labor, effort, time and errors due to human negligence to control the various home appliances, and can actuate electrical driven devices just by the voice commands according to your need and comfort. The proposed system consists of a voice recognition module, Arduino Uno microcontroller, relay circuit and radio frequency transmitter and receiver. The voice recognition module needs to be trained first before it can be used to recognize commands. Upon successful recognition of voice command, the Arduino drives the corresponding load with the help of the relay circuit.

Keywords- *Wireless Technology, 8051 Family, Transmitter*

I. INTRODUCTION

Speech recognition systems has made it possible to have what is often referred to as a "smart home", a home that can detect and identify you voice automatically adjust the lighting to your predefined taste, open doors automatically, water your flower in the morning, switch on the security lights at night and switch them off in the morning, heat water for bathe and tea, stream to you anywhere in the world via the internet a live video of what is happening in around your house. It makes it possible to link lighting, entertainment, security, telecommunication, heating and air conditioning into centrally controlled system. This allows you to make your house an active partner in managing your busy life. Speech is the most natural way humans communicate. While this has been true since the dawn of civilization, [Wikipedia Report] the invention and widespread use of the telephone, audio-phonic storage media, radio, and television has given even further importance to speech communication and speech processing. The advances in digital signal processing technology has led the use of speech processing in many different application areas like speech compression, enhancement, synthesis, and recognition. The concept of a machine that can recognize the human voice has long been an accepted feature in Science Fiction. From (Star Trek, 1984 [Film]. Directed by George Orwell's) Actually, he was not used to writing by hand. Apart from very short notes, it was usual to dictate everything into the speak writer. It has been commonly assumed that one day it will be possible to converse naturally with an advanced computer-based system. (www.ijetea.com).In computer science and electrical engineering, speech recognition (SR) is the translation of spoken words into text. It is also known as "automatic speech recognition" (ASR), "computer speech recognition", or just "speech to text" (STT). Speech recognition applications include voice user interfaces such as voice dialing (e.g. "Call home"), call routing, search (e.g. find a podcast where particular words were spoken), simple data entry (e.g., entering a credit card number), preparation of structured documents (e.g. a radiology report), speech-to-text processing (e.g., word processors or emails)and aircraft (usually termed Direct voice input). (www.Wikipedia.com). The term voice recognition or speaker identification refers to identifying the speaker, rather than what they are saying

II. RELATED WORKS

Automation is the use of control system and information technology to control equipment, industrial machinery and process, reducing the need for human intervention. In the scope of industrialization, automation is a step beyond mechanization. Mechanization enables humans to operate with machinery to assist them with the physical requirement of work while automation greatly reduces the need for human sensory and mental requirement as well (Wikipedia).

The Concept of Home automation has been around since the late 1900s [Wikipedia Report]. Sriskanthan, *et al*. [2002] and Kanma,*et al*. [2003] implemented a home automation system using Bluetooth that can be accessed remotely through GPRS. Alheraish, [2004] implemented a home automation system using SMS. Alkar and Buhur [2005] implemented a home automation system using Internet for enabling remote home access and infrared technology for device communication within the home. Atukorala, *et al*. [2009] also implemented a home automation Security System called Smart-Eye using General Packet Radio Service (GPRS). Muhury and Habib [2012] implemented a DTMF-based home automation system in which the user calls a SIM number assigned to the home and presses the digits on their phone's keypad to control the home's devices by generating a DTMF tone. Automation has been around since the world war 1 [1914], in fact, the television remote (a simple home automatic system) was patented in 1893(Wikipedia, 2009). Since then,

different automation system has evolved with a sharp rise after the second war world. Its growth has been through informal research and design by technology enthusiasts who want a better way getting things done without much effort done on their part.

III. DESIGN METHODOLOGY

A. Circuit Layout

The command is imputed by means of a voice recognition device interfaced with an Arduino Uno module. This imputed command is transmitted by the RF transmitter interfaced with the Arduino module to the RF receiver which is also interfaced with another Arduino module at the receiving end. An 8-way Relay which functions as a switch is interfaced with the Arduino module at the receiving end that puts on and off the load connected to each of the relay according to the given command. The block diagram is shown below.

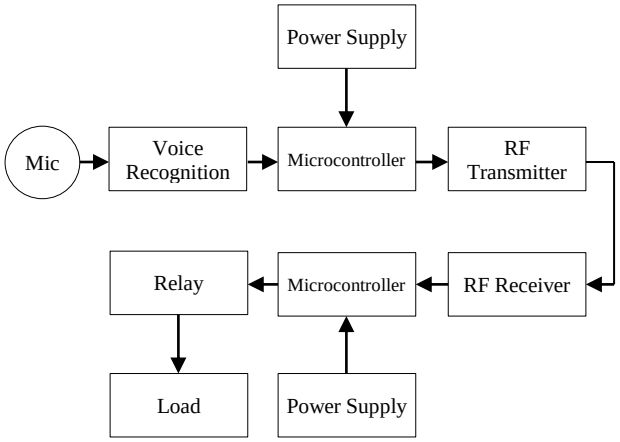

Figure 1. Block Diagram of the Voice Control System

The circuit made use of an embedded system and wireless module in controlling several loads. The design is made up of the software and hardware part. The hardware parts consist of the power supply unit, the microphone unit. (voice Recognition module), the transmitting Microcontroller(Arduino), RF transmitter, RF receiver, the receiving Microcontroller (Arduino) and Relay. The power supply unit supplies power to the whole circuit. It serves as the main source of power supply to the circuit as well as the output units. It is made up of the power supply unit. It consists of the following component, Transformer12v-0v-12v, Bridge rectifier, Capacitor, Voltage regulators, Indicators and Resistor.

B. Micro phone and the Voice recognition device

The input unit is made up of the Micro phone and the Voice recognition device (Ultrasonic sensor).

Figure 2. Diagram of Voice recognition module

The Ultrasonic processing is similar to radar. The Ultra high frequency acoustic tone is thrown at a moving object, the reflection produced are recorded by a receiver. The Doppler effect governs the frequency of the tone reflected, the equation for it can be expressed as*:* $F=F_O(1+Vc)$

Where

F_0 =emitted tone frequency

F = reflected tone frequency

V= velocity of reflecting surface towards the emitter

c =speed of sound

The voice recognition module was designed for the purpose of receiving commands from the human voice. It has a transducer (microphone) that converts the sound energy into an electrical energy. The electrical signal is converted into binary bits by the module and the output is sent to the microcontroller.

C. Microcontroller (Arduinor Uno ATmega328p)

The microcontroller used is an Arduinor Uno ATmega328p, is an open source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller and a piece of software, or IDE (Integrated Development Environment) that runs on your computer used to write and upload computer code to. the physical board. Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board, you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C language, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet and even your smart-phone or your TV! The Arduino is the brains behind this research work.

D. Technical Specifications 0f an Arduino Uno

TABLE I. SHOWING SPECIFICATIONS OF THE ARDUINO

Microcontroller	**ATmega328**
Operating voltage	5V input voltage (recommended) 7-12V input voltage (limits)
Digital I/O pins	14 (of which 6 are PWM output)
Analog input pins	6
PWM Digital I/O pins	6
Dc current per I/O pin	20Ma
Dc current for 3.3V pin	50Ma
EEPROM	1KB
SRAM	2KB
Clock speed	16MHz
Flash memory	32KB of which 0.5Kb used by bootloader
Length	**68.6mm**

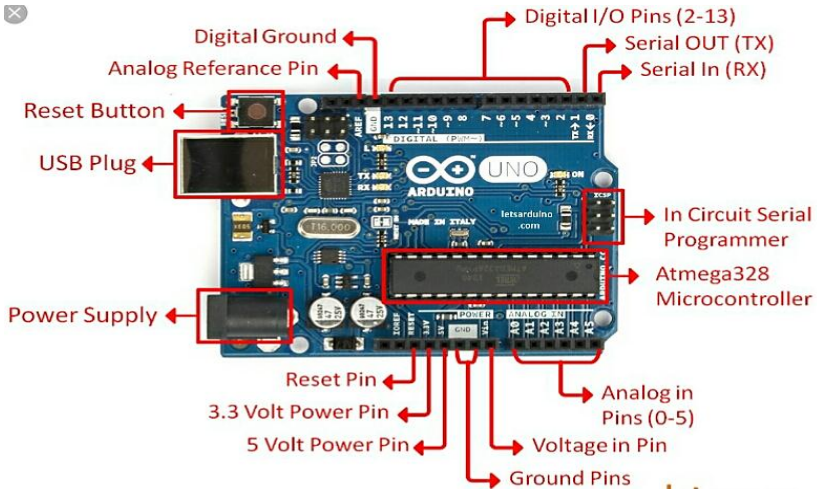

Figure 3. Diagram of an Arduino Atmega328p

E. RF Transmitter modules

An RF Transmitter module is a small PCB sub assembly capable of transmitting radio have and modulating that wave to carry data. Transmitter modules are usually implemented alongside a micro controller (Arduino) which will provide data to the module which can be transmitted.

Figure 4. Diagram of RF Transmitter

RF Transmitters are usually subject to regulatory requirement which dictate the maximum allowable transmitter power output harmonies and band edge requirements.

Working voltage: 3V – 12V F_o max.power use 12V

Working current: max less than 40Ma max, and min 9mA

Resonance mode: (SAW)

Modulation mode: ASK

Working frequency: 315MHz-433.92MHz

Transmitting power: 25Mw (315MHz at 12V)

Frequency Error: +150 KHz (max)

Velocity: less than 10kps

F. RF Receiver Modules

An RF receiver module receives the modulated RF signal, and demodulates it and is usually implemented alongside a microcontroller, which will provide data to the module.

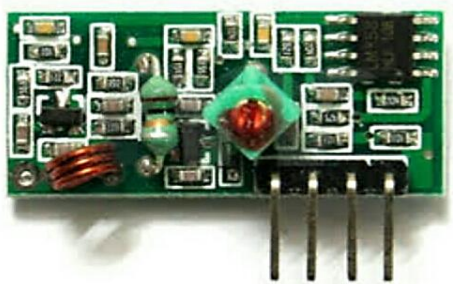

Figure 5. Diagram of RF Receiver

Working voltage: 5.0VDC + 0.5v

Working current: ≤5.5mA max

Working method: OOK/ASK

Working frequency: 315MHz-433.92MHz

Bandwidth: 2MHz

Sensitivity: excel -100dBm (50Ω)

Transmitting velocity: <9.6kps (at 315MHz and -95dBm)

The RF receiver/transmitter used in this work can cover a distance of 20m.

G. Software Design

The software used for this work is listed below.

PROTEUS VSM (Virtual system modeling). The schematics of the system starting from the power supply system to the main circuitry were designed using this software before the main construction work began. The diagram is shown below.

The programming interface used for coding the micro controller is C with a compiler called Arduino IDE.

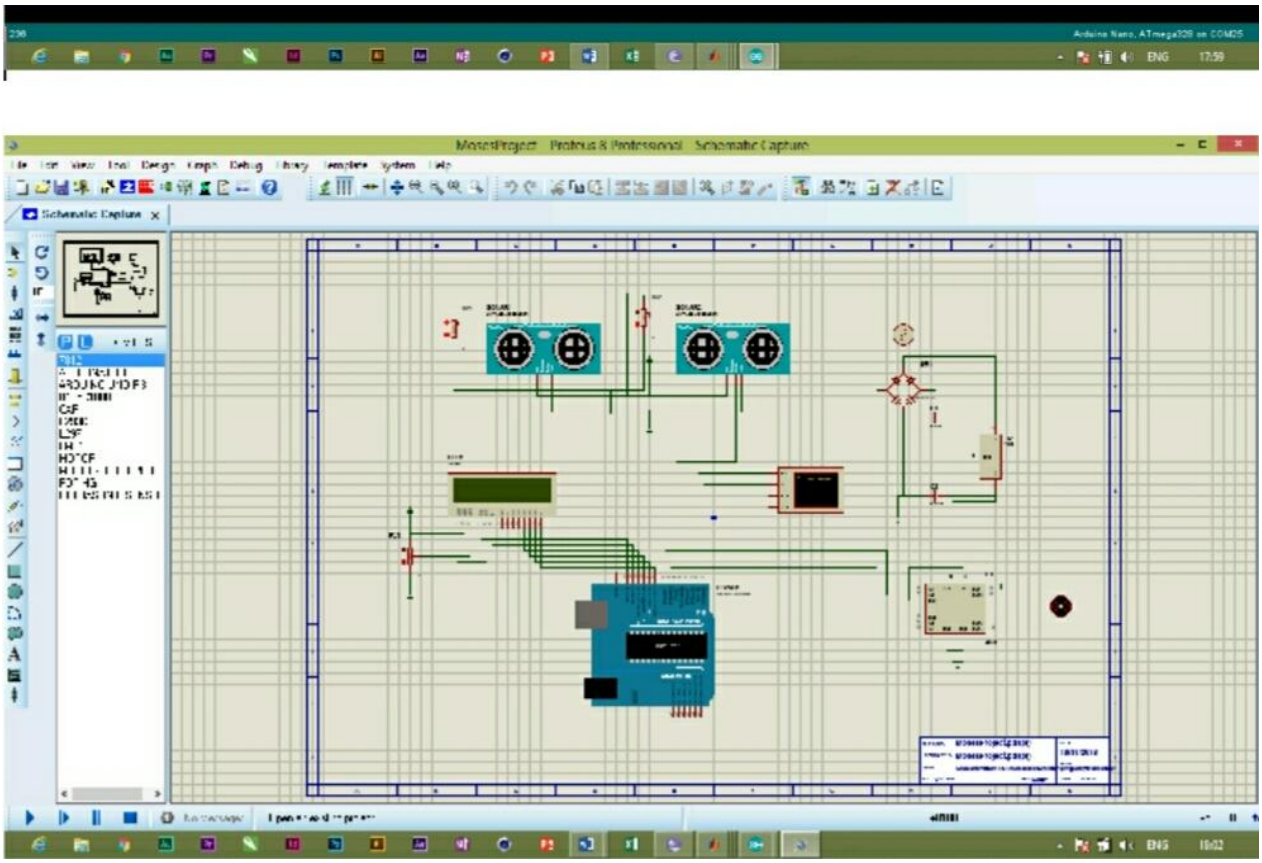

Figure 6. Interface of the Proteus working environment

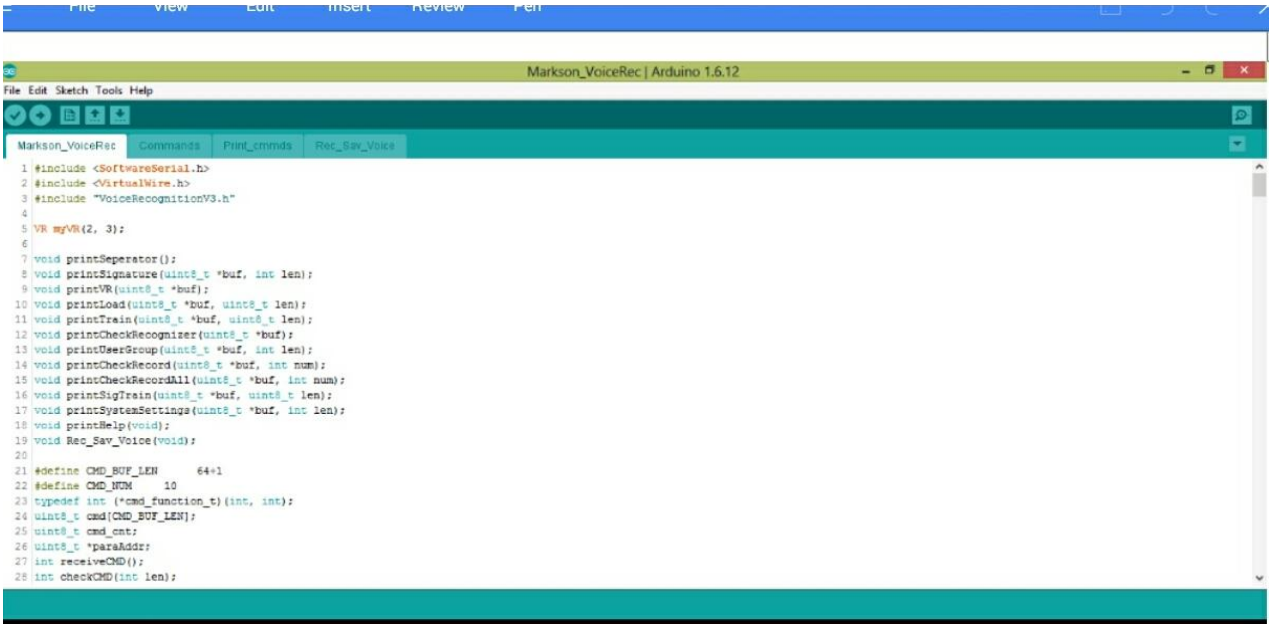

Figure 7. Interface of IDE working environment

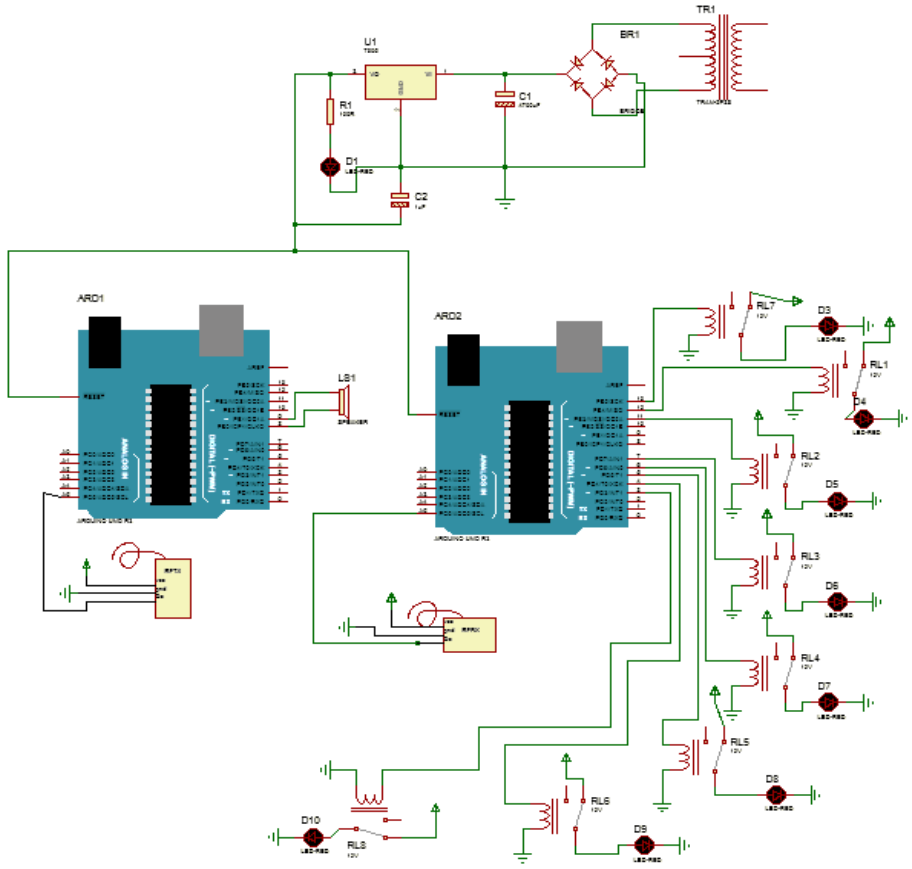

Figure 8. Circuit Layout of Microcontroller Based Voice Recognition

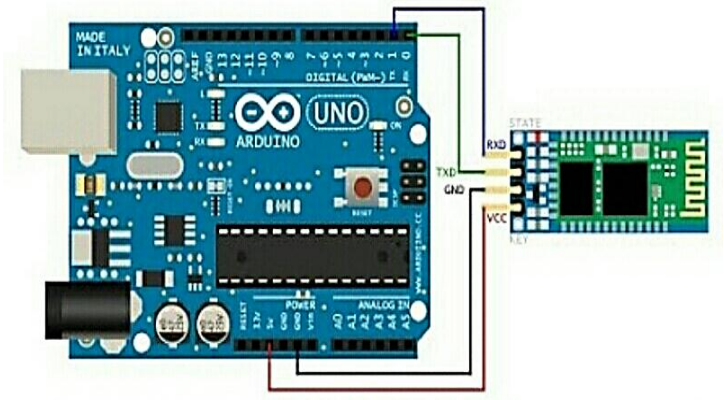

Figure 9. Diagram of Interfacing of Voice recognition module and Arduino module

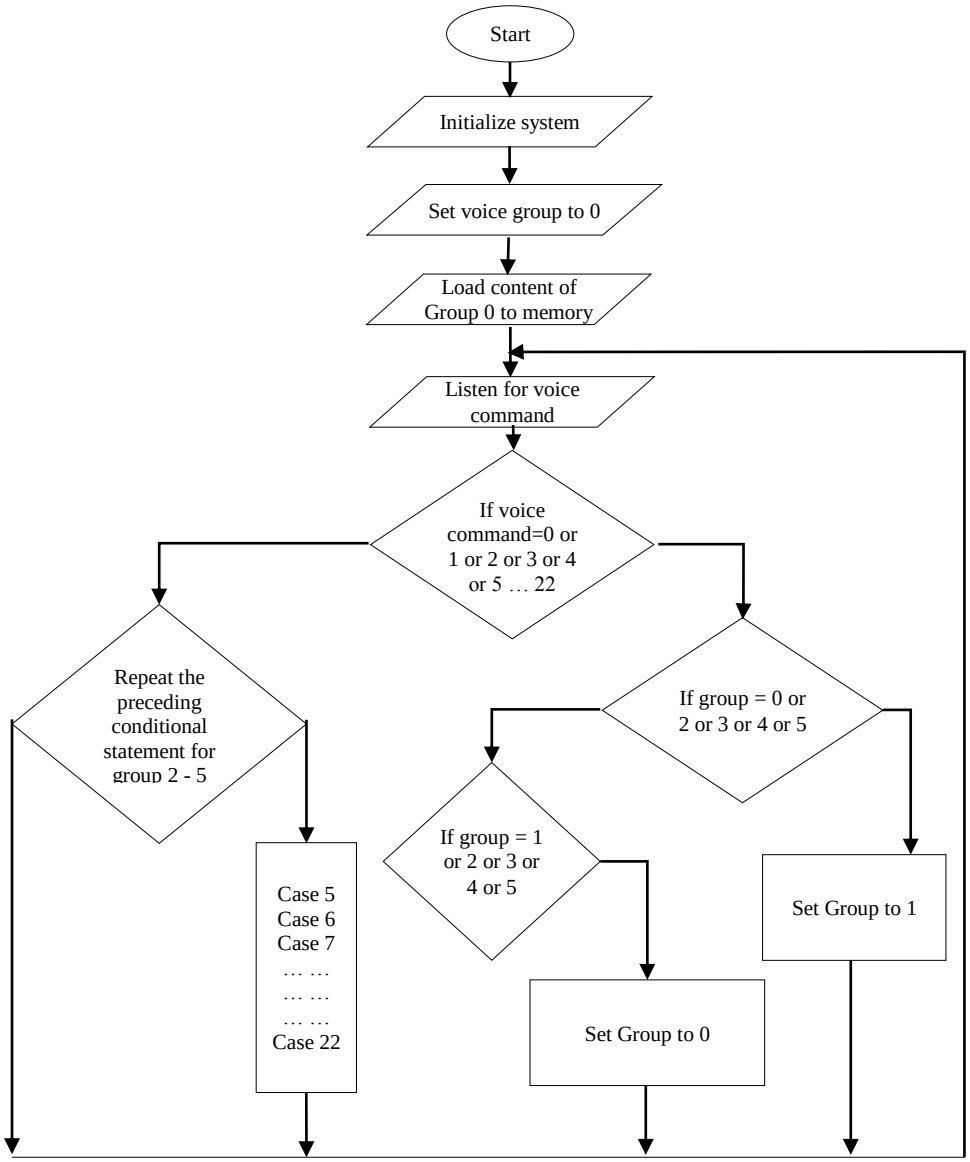

Figure 10. Flowchart From The Transmitting End

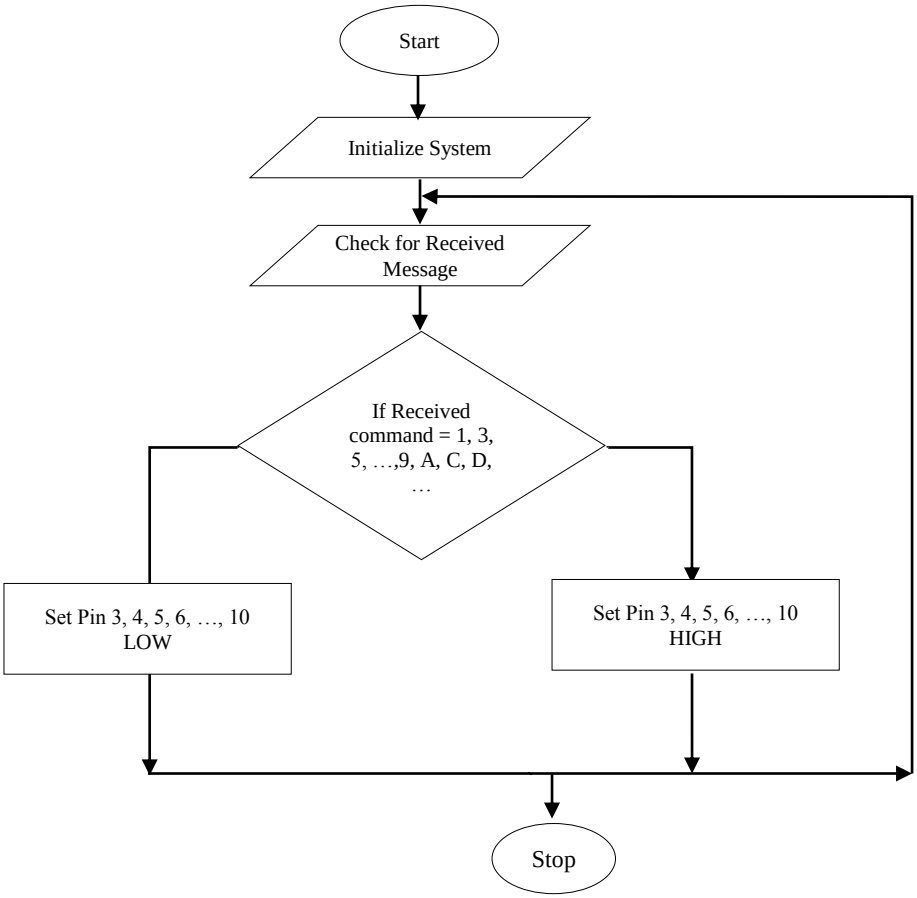

Figure 11. Flowchart for The Receiving End

IV. TEST AND RESULT

Testing is one of the important stages in the development of any new product or repair of existing ones. Because it is very difficult to trace a fault in a finished work, especially when the work to be tested is too complex. For the efficient working of this work and to ensure its reliability this project, two stages of testing were carried out, which involved:

i. Pre-implementation testing

ii. Post-implementation testing

A. Pre-Implementation Testing

This test was carried out on each of the components before they are soldered to the Vero board. This is to ensure that each component is in good working condition before they are finally soldered to the main board. The components used in this design are grouped into two.

i. Discrete components e.g. resistors, light emitting diodes, capacitors, transistors. etc.

ii. Integrated circuit components e.g. Microcontroller, voltage regulator etc.

The discrete components are tested with a digital multi-meter by switching the meter to the required value and range corresponding to each discrete component to check for continuity, resistance, capacitance etc. a detailed explanation is shown below.

B. Post-Implementation Testing

After implementing the circuit on a project board, the different sections of the complete system were tested to ensure that they were in good operating condition. The continuity test carried out is to ensure that the circuit or components are properly linked together.

This test was carried out before power was supplied to the circuit. Finally, after troubleshooting has been done on the whole circuit, power was supplied to the circuit at the voltage shown in Table 4.1. Visual troubleshooting was also carried out at this stage to ensure that the components do not burn out. The circuit was programmed by the use of C language and Different load was added or connected to the power outlet ranging from 25 watts to 200 watts of power to check if the circuit can carry it without any effect to the circuit. After all the test and observations as explained above, the project was now certified ready for packaging. The test value is shown below.

C. Testing of Working principle of the system

Firstly, 220V AC supply is converted to 5V DC using 12V step down transformer, Round bridge rectifier, smoothening

circuit and LM7805 Voltage regulator. The working principle of speech recognition comprises of the fact that command given by any person generates vibrations or disturbances called as sound pulses.

These analog waveforms are converted to digital form and decoded to appropriate commands including words and sentences. Initially, train the voice recognition module with the suitable commands and say the commands after that. The commands will be stored in binary form and fed to Arduino Uno Atmega328p microcontroller through 8-bit data bus. The microcontroller operates according to the program fed into it. Port B is used to take input from voice recognition module and Port C is used to control output devices. According to the program fed, microcontroller will respond to the instructions and will turn on/off the devices as and when required.

The system was designed to receive specific words that were assigned for controlling several loads respectively. The following keys were used to control the system as shown in Table 2.

TABLE II. FUNCTIONS BUTTONS OF THE VOICE CONTROL

Voice control inputs	**CONTROL FUNCTION**
1	FAN LEVEL 1
2	FAN LEVEL 2
3	FAN LEVEL 3
4	ON Bulb 1
5	OFF Bulb 1
6	ON Bulb 2
7	OFF Bulb 2
8	ON Bulb 3
9	OFF Bulb 3
10	ON Socket 1
11	OFF Socket 1
12	ON Socket 2
13	OFF Socket 2

V. RESULTS

The results obtained from Table after the test showed that the system is working perfectly. The microcontroller functions according to the program used for the software design implementation.

The voice recognition system was first tested in a quiet room with one user. All commands were correctly recognized by the system. Next we tested it with a different user on whom the system was not trained.

About 5% errors occurred here, for example words like "accept" were recognized as "except". This was because the recognizer heard a different pronunciation. Although, if the person had spoken the command multiple times the recognizer had sufficient examples to properly determine what pronunciation the person spoke.

Then we tested the project in a noisy room by turning on some music in that room.

When the sound was light there was no problem in correctly recognizing the words but when we increased the volume the recognizer found it difficult to recognize the user's voice and often took commands from what it heard in the song.

VI. CONCLUSION AND RECOMMENDATION

Construction of a Voice control system was of a truth a fascinating task to undergo. The climax of the whole process was to see that the hardware and software implementation are working as desired after several process of trial and adjustment. This project has provided us a great deal of insight into the field of communication and control engineering. This work was designed and constructed considering some factors such as economic applications, design economy, availability of components and research materials, efficiency, reliability, compatibility and also durability. However, the general operation of this work and performance is dependent on the user who is prone to human error such as careless handling or lack of adequate maintenance. Other factor that might affect performance includes packaging ventilation, quality of component, handling usage and transportation. The construction was done in such a way that it makes maintenance and repairs an easy task and affordable for the user, should there be any system breakdown. In general, this work can be found establishments such as banks restaurants, churches, colleges, airport and other organizations. It gives an alternative way of putting on/off electrical Appliances without going close to the switch.

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